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(71) Applicant (for all designated States except US): **BMC S.R.L.**, [IT/IT]; Via Roslè, 115, I-40059 Medicina (IT).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **BERGAMI, Gaetano** [IT/IT]; Via Roslè, 1001, I-40059 Medicina (IT).

(74) Agent: **AGAZZANI, Giampaolo**; Agazzani & Associati S.r.l., Via dell'Angelo Custode, 11/6, I-40141 Bologna (IT).

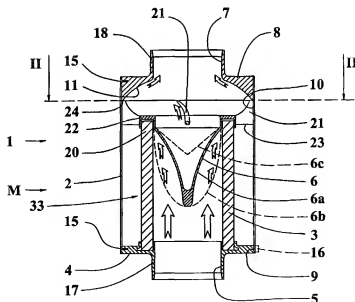
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(54) Title: METHOD FOR ESTIMATION OF THE AIR QUANTITY IN THE INTAKE AND EXHAUST MANIFOLD OF AN INTERNAL COMBUSTION ENGINE WITH EGR



(57) Abstract: A device for filtering the intake air of combustion engines includes a filter (33) intercepting the air flowing along a tubular housing (2) for the filter (33). An end of this latter is connected to a lower mouthpiece (9) of the housing (2) through support means (4). The device (1) has a plurality of connection means (21) interposed between the free ends (20) of said filter (33) and the housing (2). The connection means (21) have a fin shape and are fit to strengthen the connection between tubular housing (2) and the filter (33) and fit for controlling the air flow in the device (1).

METHOD FOR ESTIMATION OF THE AIR QUANTITY IN THE INTAKE AND EXHAUST MANIFOLD OF
AN INTERNAL COMBUSTION ENGINE WITH EGR

TECHNICAL FIELD

- 5 The present invention relates to devices for relates to devices for filtering the combustive air for engine for instance internal combustion engine.

Particularly the present invention refers to a device for filtering the intake air of internal combustion, supercharged and aspirated, engines especially with high performances.

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BACKGROUND ART

As known in the automotive field, the air filtering has particular importance since avoids the inlet of foreign matter inside the engine.

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At the same time the air filtering conditions the gasoline and air mixing and therefore the so obtained fuel mixture used in the combustion.

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The known air filters are normally flattened, cylindrical or conical shaped and are contained into a related case with inlet openings of the environmental air and outlet openings of the filtered air.

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There are known filters for the use in sporting engines, the usually called "sprint filter", which have filters truncated cone shaped which are enclosed in metallic containers shaped as almost conic or truncated-conic portions. The filtering elements of said known filters are made of polyester or paper and have heavy flanges and/or caps generally made of polyurethane.

30

The main drawback of said known devices consists in that the filter polyurethane flange can be detached from the filtering portion because cracks and yielding due to the aging of the material so causing the non-filtering of the air, the possible obstruction of the ducts with motor stop and the possible entry into the motor of fragments of the same filter or its support.

Another drawback consists in the high air flow resistance downstream the filter caused by the turbulence.

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A further drawback consists in that the polyurethane flanges and caps are too heavy and

expensive and cannot withstand temperatures greater than 90° C, possible in the high performance engines.

Further drawbacks consist in the polyester filtering elements because their so-called “sponge effect” which causes technical problems for the sporting engines in presence of high humidity, and in the paper filtering elements, which have an excessive air flow resistance.

Another drawback consists in the too high temperature achieved inside the known device containers because the metallic material used for said containers.

DISCLOSURE OF THE INVENTION

The main object of the present invention is to propose a device for filtering the intake air of internal combustion engines which is very sturdy and reliable, fit to withstand typical mechanical stresses of the sporting vehicles and temperatures up to around 250° C and at the same time light and suitable to reduce air flow resistances.

Further object of the present invention is to propose a device fit to thermally insulate the crossing air flow, without the sponge effect and having a high air filtering value and a low production cost.

Further object is to propose a device having a life greater than a distance of about 300.000 km, however usable with a very low maintenance and having a filter easy to dispose, because primarily made of a natural material.

Another object is to propose a device having small external dimensions still preserving the most wide internal volume.

BRIEF DESCRIPTION OF THE DRAWINGS

The characteristics of the invention are underlined in the following with particular reference to attached drawings, in which:

- figure 1 shows a longitudinal section view of the preferred embodiment of the device object of the present invention;

- figure 2 shows a section view according to the plane II-II of the figure 1 device, in which some parts have been removed for better underlining others;
- figures from 3 to 6 show longitudinal section views of corresponding variants of the device;
- figure 7 shows a plan view of the device of figure 6;
- 5 - figure 8 shows a section view according to the plane VIII-VIII of figure 7.

BEST MODE OF CARRYING OUT THE INVENTION

10 With reference to figures 1 and 2, numeral 1 indicates a device for filtering the intake air of internal combustion engine including a filter 33, a tubular housing 2 for the filter 33 and support means 4.

The tubular housing 2, right cylindrical shaped, has opening portions lower 9 and upper 10 and is made preferably of carbon fiber.

15 In correspondence of an assemblage condition M, duct means 8 are fixed to the tubular housing 2 through fastener means 15, for instance consisting of screws or pins; the duct means 8 have an upper mouthpiece 18 extending outwardly the housing 2 and an upper opening 7 for the air flow.

20 Fillet means 11 are carried out in the duct means 8 and consist of a curved fillet surface which conveys the aerodynamic air flow. The fillet means 11 of the duct means 8 form a shoulder 24 with the upper opening portion 10.

25 The filter 33 includes at least a filtering element 3, for instance made of cotton saturated with low viscosity oil enclosed between two layers of metallic net, for instance made of aluminium. The wall of the filtering element 3 is refolded several time at saw teeth in order to increase the surface and is approximately cylinder shaped.

30 An end of the filter 33 is fixed, for instance by means of resins, to an annular housing of the support means 4 that are made of, for instance, carbon fibre or nylon strengthened with glass fibre.

The support means 4 have a lower mouthpiece 17 which extends outwardly the housing 2 and has a lower opening 5 for the air flow.

The free end 20 of the filter 33 is connected to at least a three connection means 21 which mate the inner wall of the housing 2 in correspondence of the upper opening portion 10.

- 5 The connection between the free end 20 of the filter 33 and each of the connecting means 21, is carried out by an annular mean annular mean 22 fixed to said free end 20, for instance by means of resins.

- 10 In the assemblage condition M of the device 1, the support means 4 are fixed to the lower opening portion 9 of the tubular housing 2 through fastener means 15, for instance consisting of screws or clamps 16, and the connection means 21 match the shoulder 24.

The annular mean 22 is centrally provided with air deflectors 6 having a conic shape with concave profile 6a or convex 6b or triangular 6c.

- 15 The air deflectors 6 obstruct completely the free end 20 of the filter 33 and protrude inwardly this latter. The profile shape of the air deflectors 6 is defined according to the air speed and the dimensional characteristics of the filter 33.

- 20 The connection means 21, the annular mean 22 and the air deflectors 6 are made in a single body of carbon fibre or nylon strengthened with glass fibre.

- It is also provided that the connection means 21 can be fixed to the tubular housing 2 or to the duct means 8 and that in the assemblage condition M, the connection means 21 may match the
25 annular mean 22.

Each connection mean 21 is shaped like an aerodynamic fin having a leading edge 23 directed in the air flow direction.

- 30 Each leading edge 23 has a substantially radial development with respect to the filter 33.

The chord, the profile and the possible twist of each fin, constituting each connection mean 21, depend on the dimensional characteristics of the device 1 and on the air speed and, generally they have values inversely proportional to said speed.

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The operation of the preferred embodiment of the device 1, provides that the upper mouthpiece 18 is connected, for instance through clamps, to an intake collector of the combustive air of a combustion engine. The engine starting provokes the air flow which is sucked, by depression, through the lower opening 5 entering inside the filter 33. The air deflectors 6 contribute to the homogeneous distribution of the air flow through the filtering element 3. This latter holds dusts and generally the impurities carried by the air flow flowing in the hollow space between the filtering element 3 and the tubular housing 2. The flow at the exit of said hollow space run into the connection means 21 whose aerodynamic fin shape contributes to regularize said flow and to reduce its turbulence and, therefore to reduce the aerodynamic resistance. Downstream the connection means 21, the fillet means 11 direct the flow up to the upper opening 7 and, thus in the engine collector.

The connection means 21 avoid radial oscillations of the free end 20 of the filter 33 and the matching of the connection means 21 against the shoulder 24 avoids axial movements of the filter 33. Therefore the connection means 21 avoid that the mechanical stresses, such as shocks and vibrations, of the mean on which the device 1 is installed, stress excessively the junction between the filtering element 3 and the support means 4.

Then the connection means 21 advantageously strengthen the device.

It is also provided that the tubular housing 2 and/or the filter have a truncated conical shape and/or an oval section.

It is further provide a variant in which the connection means 21 and the annular mean 22 are carried out in a single body made of carbon fibre or nylon strengthened with glass fibre and the air deflectors 6 are fixed to the annular mean and are carried out in cotton interposed between two metallic nets. This variant provides an advantageous increase of the filtering surface and a reduction of the depression downstream the air deflectors 6, partially filled by the flow crossing them, with advantageous effects on the regularity of the flow and the flow rate.

In the variant of figure 3 the air deflectors 6 are external to the filtering element 3 and the tubular housing 2, the duct means 8 and the upper opening portion 7 are carried out in a single body and have a truncated conical shape. The filter 33 has a truncated conical shape as well.

In this variant, the lower mouthpiece 17 is connected to the engine collector and has a filleted

shape, for instance a trombone shape, to convey the filtered air toward said collector. The air flow enters in the device 1 from the upper opening 7.

- 5 The variant of figure 4 differs from the variant of figure 3 in that the tubular housing 2 is cylindrical and with a separated body from the duct means 8.

The variant of figure 5 differs from the variant of figure 4 in that the filter 33 and the lower mouthpiece 17 have a cylindrical shape.

- 10 The variant shown in the figures 6, 7 and 8 differs from the main embodiment of figure 1 in that includes fixing means 28, carried out in the duct means 8 in proximity of the upper opening 7 and fit for connecting the filtering device 1 to a flange 31 of a pressure gauge or a flowmeter 32, of known type for instance an hot-wire anemometer.
- 15 The flowmeter 32 is interposed between the upper mouthpiece 18 of the device 1 and an intake collector of the combustible air of a combustion engine and is fit to measure the flow rate of the air coming out from the filtering device 1.

- 20 The fixing means 28 consist substantially of a couple of threaded holes, carried out on corresponding protrusions, carried out in single body on the duct means 8, at the opposite sides of the upper opening 7.

- 25 The duct means 8 further have in correspondence of the upper opening 7, an annular seat 29, fit for housing a related gasket in order to guarantee the seal connection between the device 1 and the flowmeter 32.

It is provided on the duct means 8 a hollow protrusion 30 for the connection to possible engine devices or members, for instance for connecting a hose for the recovery of the oil vapours.

- 30 The protrusion 30 has a blind longitudinal hole 31 that, if required for allowing the flow communication, can be easily full perforated during the assemblage phase of the device 1 on the related engine.

It is evident that in case the lower mouthpiece 17 is connected to the intake collector of the engine, the air flow entering into the device 1 through the upper opening 7, the fixing means 28, the annular seat 29, the protrusion 30 are carried out in the support means 4.

- 5 The main advantage of the present invention is to provide a device for filtering the intake air of internal combustion engines which is very sturdy and reliable, fit to withstand high mechanical stresses and temperatures up to around 250° C and at the same time light and suitable to reduce air flow resistances.
- 10 Further advantage of the present invention is to provide a device fit to thermally insulate the crossing air flow, without the sponge effect and having a high air filtering value, a low production cost, and a life greater than a distance of about 300.000 km, and having a filter easy to dispose.
- 15 Another advantage is to provide a device having small external dimensions still preserving the most wide internal volume.

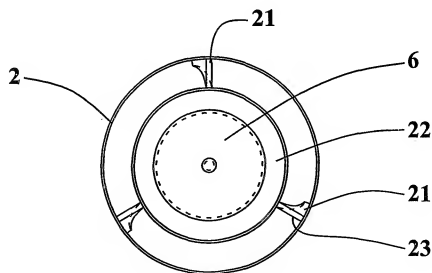
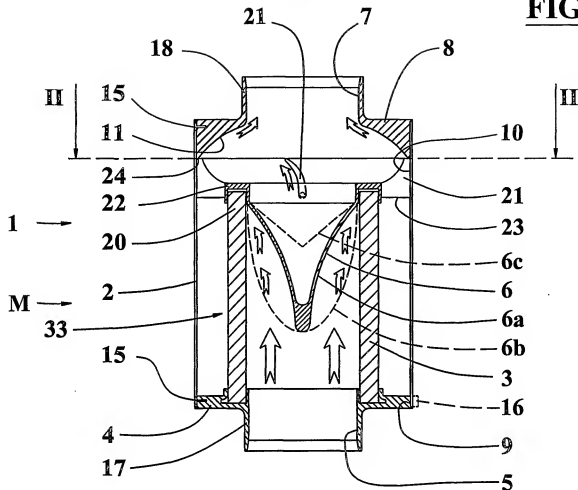
CLAIMS

- 1) Device for filtering the intake air of combustion engines and including a filter (33) intercepting the air flowing along a tubular housing (2) for the filter (33), an end of this latter being connected to an lower mouthpiece (9) of the housing (2) through support means (4), said device (1) being characterized in that a plurality of connection means (21) are interposed between the free ends (20) of said filter (33) and the housing (2) and are fit at least to strengthen the connection between tubular housing (2) and filter (33).
- 2) Device according to claim 1 characterized in that each of said plurality of connection means (21) is fin shaped with a leading edge (23) directed in the air flow direction.
- 3) Device according to claim 2 characterized in that the leading edge (23) has a substantially radial development with respect to the filter (33).
- 4) Device according to any of the preceding claims characterized in that each of said plurality of connection means (21) is fixed to a annular mean (22) associated to said free end (20) of the filter (33).
- 5) Device according to claim 4 characterized in that the annular mean (22) has air deflectors (6).
- 6) Device according to claim 5 characterized in that the air deflectors (6) have conical shape with concave (6a) or convex (6b) or triangular (6c) profile.
- 7) Device according to any of the preceding claims characterized in that each of the plurality of connection means (21) matches a shoulder (24) of fillet means (11) which conveys the air flow.
- 8) Device according to claim 7 characterized in that the fillet means (11) are carried out in duct means (8) fixed in correspondence of the upper opening portion (10) and having an upper opening (7) to convey the air coming out from the device (1).
- 9) Device according to claim 8 characterized in that the duct means (8) are in single body with the tubular housing (2).

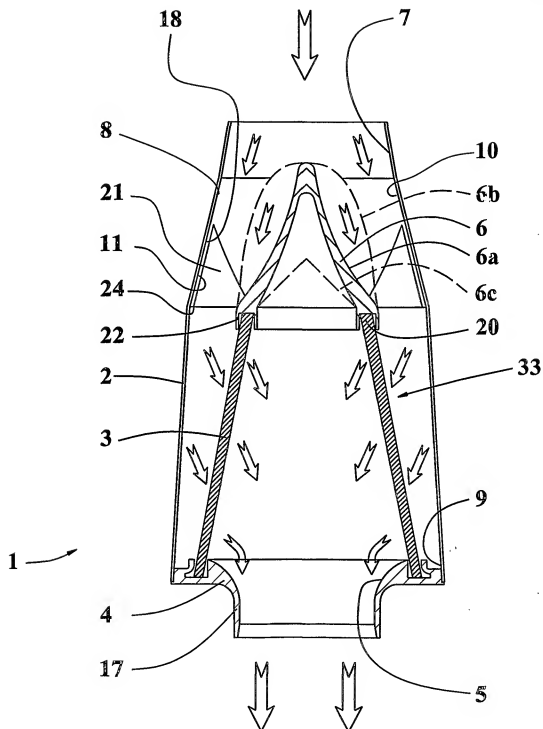
- 10) Device according to claim 8 characterized in that the air deflectors (6) extend inwardly the filter (33).
- 11) Device according to claim 9 characterized in that the air deflectors (6) are external to the
5 filter (33).
- 12) Device according to claim 8 characterized in that the duct means (8) have fastener means (15) for fixing to the tubular housing (2).
- 10 13) Device according to claim 1 or 8 characterized in that includes fixing means (28) for the connection with a pressure gauge or flowmeter or an air-speed meter (32), carried out in the support means (4) or in the duct means (8).
- 14) Device according to claim 13 characterized in that includes an annular seat (29) carried out
15 in the support means (4) or in the duct means (8), respectively in correspondence of a upper opening (7) or lower opening (6).
- 15) Device according to the claim 1 or 8 characterized in that includes at least a protrusion (30) with a longitudinal hole, carried out in the support means (4) or in the duct means (8).
- 20 16) Device according to any of the preceding claims characterized in that the support means (4) have fastener means (15) for fixing the tubular housing (2).
- 17) Device according to any of the preceding claims characterized in that said tubular housing
25 (2) is made of carbon fibre.
- 18) Device according to any of the preceding claims characterized in that said filter (33) includes at least a filtering element (3) made of cotton saturated with low viscosity oil.
- 30 19) Device according to claim 18 characterized in that the filtering element (3) includes two layers of metallic net enclosing the cotton.
- 20) Device according to any of the preceding claims characterized in that said support means (4) are made of carbon fibre or nylon strengthened with glass fibre.
- 35

- 21) Device according to claims 5 characterized in that the air deflectors (6) are made of cotton saturated with low viscosity oil and interposed between two layers of metallic net.
- 22) Device according to claim 18 characterized in that said filtering element (33) has at least a
5 cylindrical or truncated conical portion.
- 23) Device according to claim 8 characterized in that the duct means (8) are made of carbon fibre or nylon strengthened with glass fibre.
- 10 24) Device according to claim 5 characterized in that the connection means (21), the annular mean (22) and the air deflectors (6) are carried out in a single body made of carbon fibre or nylon strengthened with glass fibre.

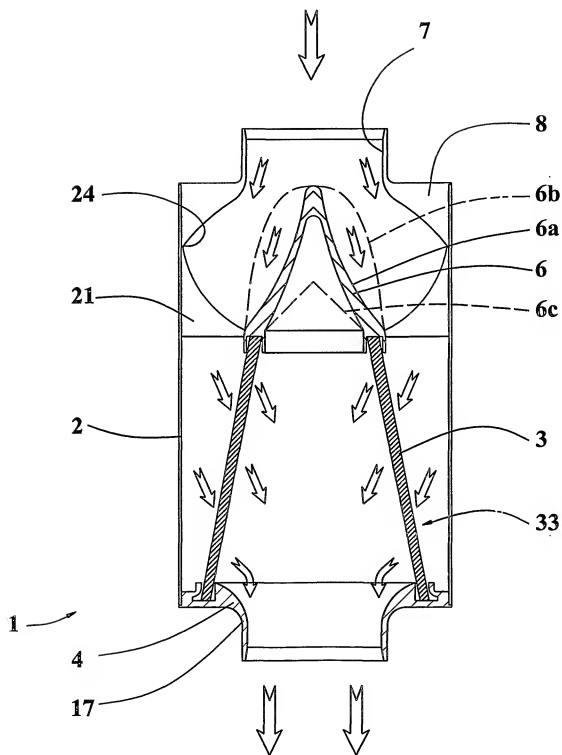
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FIG.1**FIG.2**

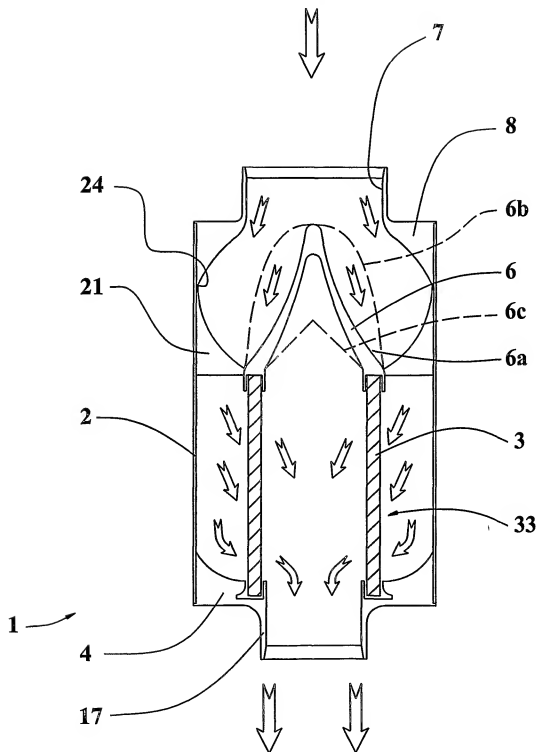
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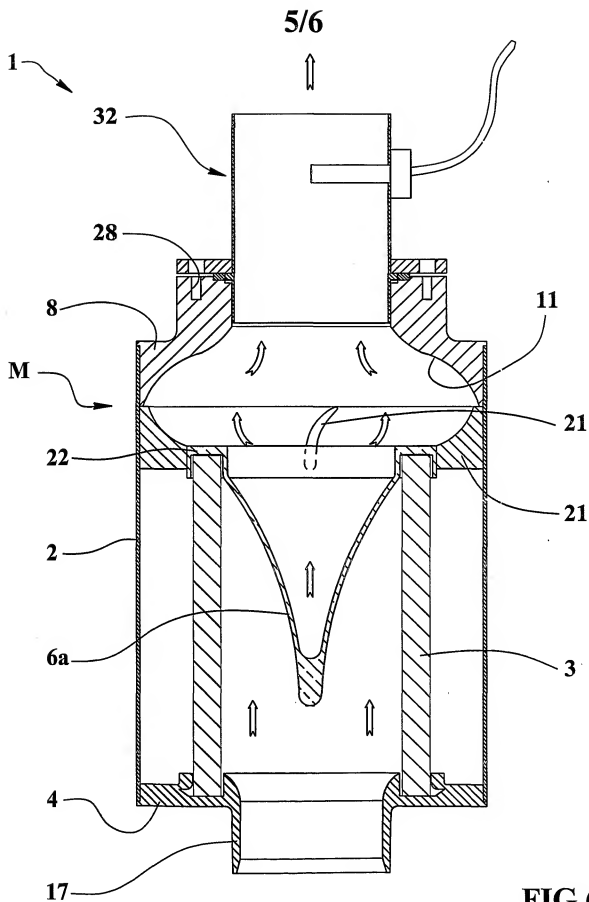
FIG.3

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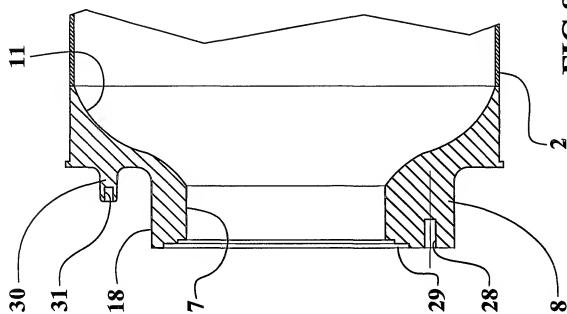
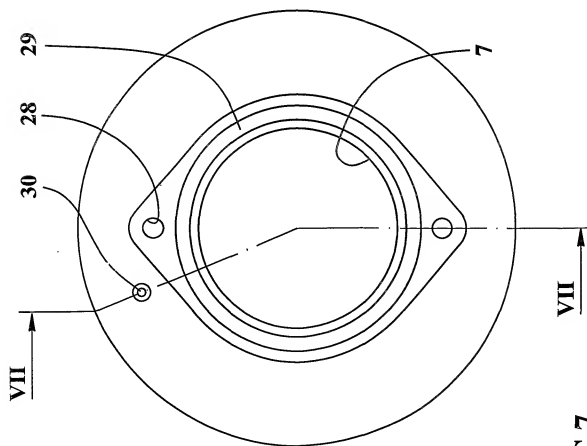
FIG.4

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FIG.5

**FIG.6**

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**FIG. 8****FIG. 7**

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F02D41/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F02D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR 2 789 731 A (RENAULT) 18 August 2000 (2000-08-18) the whole document ---	1-14
P,A	DE 100 17 280 A (BOSCH GMBH ROBERT) 11 October 2001 (2001-10-11) the whole document ---	1-14
X	AMSTRUTZ A ET AL: "EGO SENSOR BASED ROBUST OUTPUT CONTROL OF EGR IN DIESEL ENGINES" IEEE TRANSACTIONS ON CONTROL SYSTEMS TECHNOLOGY, IEEE INC. NEW YORK, US, vol. 3, no. 1, 1 March 1995 (1995-03-01), pages 39-48, XP000508609 ISSN: 1063-6536 the whole document ---	1-14

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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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21 May 2002

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European Patent Office, P.B. 5818 Patentkan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 974 870 A (ROESEL GERD ET AL) 2 November 1999 (1999-11-02) column 2, line 38 -column 5, line 21 -----	1
A	CHEN-FANG CHANG ET AL: "AIR-FUEL RATIO CONTROL IN SPARK-IGNITION ENGINES USING ESTIMATION THEORY" IEEE TRANSACTIONS ON CONTROL SYSTEMS TECHNOLOGY, IEEE INC. NEW YORK, US, vol. 3, no. 1, 1 March 1995 (1995-03-01), pages 22-31, XP000508607 ISSN: 1063-6536 page 23, paragraph B page 26, paragraph E -page 27 -----	1-14
A	EP 0 719 919 A (HONDA MOTOR CO LTD) 3 July 1996 (1996-07-03) page 5, column 28 -column 54 figures 19,37,41,42 -----	1

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
FR 2789731	A	18-08-2000	FR	2789731 A1	18-08-2000
			EP	1153212 A1	14-11-2001
			WO	0047884 A1	17-08-2000
DE 10017280	A	11-10-2001	DE	10017280 A1	11-10-2001
			WO	0177509 A1	18-10-2001
US 5974870	A	02-11-1999	BR	9708197 A	27-07-1999
			CN	1214104 A , B	14-04-1999
			CZ	9802926 A3	12-05-1999
			WO	9735106 A2	25-09-1997
			DE	59700375 D1	30-09-1999
			EP	0886725 A2	30-12-1998
EP 0719919	A	03-07-1996	EP	0719919 A2	03-07-1996
			EP	0719930 A2	03-07-1996
			JP	3217682 B2	09-10-2001
			JP	8232723 A	10-09-1996
			US	5758490 A	02-06-1998
			JP	3217689 B2	09-10-2001
			JP	8291737 A	05-11-1996
			US	5908463 A	01-06-1999